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Nests of *Callanthidium* from Block Traps (Hymenoptera: Megachilidae)

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Abstract.—The nesting habits of *Callanthidium formosum* (Cresson) are described for the first time. Nests were obtained from block traps set at 2000–3000 m in northern Utah. Information on nest construction, cocoon formation, sex ratio, adult weights, and mortality is presented. Additional information is presented on the adult weights, cell lengths, and nest associates of *Callanthidium illustre* (Cresson).

Species of *Callanthidium* are among the largest members of the tribe Anthidiini, and our two species are marked with bright yellow integumental bands that contrast with their brownish-black body color. Many adults have been collected from a variety of flowers (Hurd et al., 1979), but nests are less commonly found and only those of *C. illustre* (Cresson) have been reported (Johnson, 1904; Hicks, 1929; Parker and Bohart, 1966). Recent biological studies using block traps (Parker, 1985a) have added information on nests of *C. illustre* and *C. formosum* (Cresson), and in this paper the nesting habits of *C. formosum* are described for the first time. Additional data are presented on sex ratios and adult weights of both species.

METHODS

One-meter stakes were driven partially into the soil and the block traps attached near the top of the stake with the holes facing southeast. The trap blocks (see Parker 1985a for details of trap design) were set out in May and recovered in November of the same year. The blocks were then taken apart and the layers split with a knife to expose the nest contents. Each nest was measured, described, and photographed; samples of pollen were removed to identify floral resources. A radiograph (Stephen and Undurraga 1976) was made of intact nests that had been removed from the block traps. Individual cell contents were placed and stored in 000 gelatin capsules, labeled and held at 3° C to break overwintering diapause. During March of the next year, the capsules were placed in a 27° C incubator, and when the adults emerged they were weighed alive, killed, mounted and identified.

C. formosum

Nesting Sites.—All nests were recovered from block traps set at higher elevations (2000–3000 m) in Logan Canyon, Farmington Canyon and along the southwestern shore of Bear Lake in northern Utah. The predominant shrubs and trees at these locations included junipers, mahogany, scrub maple, boxelder, sagebrush and ceanothus; perennial and annual forbs were abundant and diverse.

Nest Construction.—Twelve nests containing 36 cells were recovered from 10 mm diameter borings and a 2-cell nest from an 8 mm boring. The number of cells/nest ranged from 1 to 4 and averaged 3.2 (SD 1.2). The average length of male cells was 15.4 mm (SD 1.0 mm, n = 7) and this figure for female cells averaged 13.6 mm (SD 1.0 mm, n = 7). These differences between sexes and average lengths of cells were significantly different ($P < 0.004$).

The plant source of the cotton-like fibrillose material used to line the cells was undetermined. Cells were constructed from fibers that were formed into pouch-like chambers that held the provisions. These chambers were 7–8 mm wide and 11–13 mm long. The cells were separated initially by 4–5 mm thick partitions of fibers, but the partitions were compacted during cocoon formation to 1–2 mm. Above the last cell the nest was plugged with fibrillose material that averaged 34.0 mm (SD 14.3 mm long, n = 4). Most nests were capped with an entrance plug of small white pebbles stuck together with masticated leaf pulp (Fig. 1). Plugs averaged 6.0 mm (SD 1.4 mm thick, n = 4), were disc-shaped and were placed at the entrance to the nest.

Provisions.—The cup-shaped mixture of pollen and nectar (Fig. 1) was tacky when probed. The composition was about 60% mint and 40% legume pollens. The host egg was laid across the top of the provision.

Cocoon.—The mature larva initiated formation of the cocoon by flattening the fecal material and remaining provisions against the cell walls (except at the upper rim) and then lining the walls with a shellac-like layer of silk; this layer had a cone-shaped and hollow nipple at the top. Inside this layer, the second layer was barrel-shaped (see radiograph) and was formed from strands of whitish silk deposited in a cross-hatched pattern; this internal layer was brown. Beneath the nipple, the second layer was formed into a mat-like pad from coarse, brownish silk strands. A third layer of coarse, whitish silk strands that resembled cellophane covered the entire inner surface of the cocoon, including the underside of the nipple. Average length of cocoons from which males emerged was 12.3 mm (SD 0.8 mm) long, and 8.1 mm (SD 0.3 mm) wide and those from which females emerged averaged 11.3 mm (SD 0.5 mm) long and 7.1 mm (SD 0.2 mm) wide. These size differences were significantly different ($P < 0.001$).

Overwintering.—All cells contained prepupae in diapause when examined in November and all surviving overwintering prepupae pupated and emerged when incubated in March.

Adult Weights and Sex Ratio.—Average weight of males was 142.9 mg (SD 10.4 mg, range 130.3–160.5 mg, n = 7) and females averaged less, 113.8 mg (SD 18.5 mg, range 91.3–139.3 mg, n = 7). The observed and expected sex ratios (see Torchio and Tepedino 1980 for methods of calculation) were identical: 1.26 females: 1 male. There was a significant relationship between cell length and individual weight among females ($r = 0.78$, $n = 7$, $P < 0.04$) but not in males ($r = 0.51$, $n = 7$, $P < 0.24$). Placement of the sexes within cell series differed from most wood-nesting bees because males were in the bottom cells and females were above. Some nests, however, had all male or all female cells (Fig. 1).

Mortality.—Mortality of immature stages from unknown causes averaged 14.3% of the total cells. No nest associates were found nor were any of the nests superseded by other aculeates.

C. illustre

Nesting in this species has been described by several authors. Johnson (1904) reported *C. illustre* nesting in clay banks in Denver, Colorado. Hicks (1929) reported

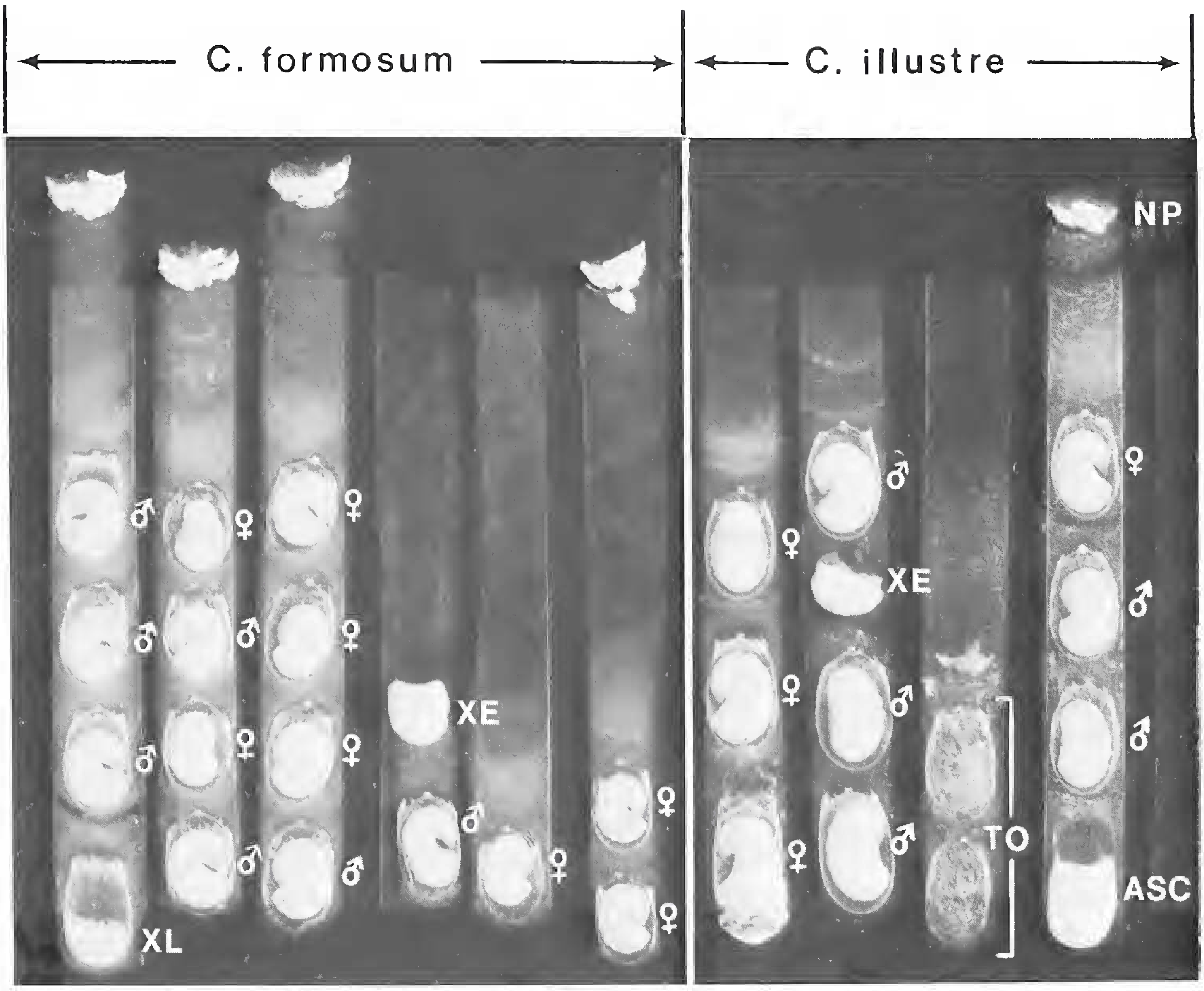

Fig. 1. Radiograph of nests of *Callanthidium formosum* and *C. illustre* illustrating placement of cells, form of the cocoon and nest entrance plugs. XL = dead larva, XE = dead egg. TO = *Trichodes ornatus* predation, ASC-*Ascosphaera* parasitism, NP = nest entrance plug.

that this bee nested in old, dead yucca flower stalks near Pasadena, California; he described their nests, adult activity and possible nest associates. Parker and Bohart (1966) reported nests in holes in wood (block traps). Grigarick and Stange (1968) summarized the biology and included photographs of the nest and cocoon. Four additional nests were obtained recently from trap blocks placed near Santa Clara in southern Utah.

All nests were made in 10 mm diameter holes. The 4 nests, containing 13 cells, averaged 3.2 cells/nest (range of 2–4 cells). Cells were separated by 3.3 mm (SD 1.6 mm) of fibrillose plant parts. One nest was finished and had a vestibule of fibrillose material 20 mm long; it was capped with a 5 mm thick plug of masticated plant parts and pebbles.

Cell size and adult weights varied considerably. Average length of cells of males was 17.2 mm (SD 1.6 mm, $n = 5$) and average length of female cells was 19.0 mm (SD 2.6 mm. $n = 4$); these averages, however, were not significantly different ($P < 0.24$). Although male bees were heavier (average weight of males was 205. 1 mg, SD 25.4

mg, n = 5; females 185.2 mg, SD 34.1 mg, n = 4), weights were not significantly different ($P < 0.35$). There was a significant correlation between cell length and adult weight in both sexes ($r = .91$, $P < 0.003$ for males; $r = .96$, $P < 0.04$ for females). Average length of cocoons from which males emerged was 14.2 mm (SD 0.8 mm) and average width was 8.7 mm (SD 0.4 mm); average length of cocoons from females was 13.8 mm (SD 0.5 mm) and average width was 8.3 mm (SD 0.3 mm). One nest had males below and a single female above, one contained males, and another contained only females.

One cell contained a bee larva infected with the fungus, *Ascosphaera* sp., and two other cells were destroyed by a larva of the clerid beetle, *Trichodes ornatus* Say.

Discussion

The placement of sexes within *Callanthidium* nests differed from the usual pattern in xylophilous nesting bees in that females were at the bottom and males were at the top (Krombein, 1979). Males of Anthidiine genera such as *Callanthidium, Anthidium* and *Dianthidium* are larger and weigh more than females (Alcock, 1977; Alcock et al., 1977; Frohlich and Parker, 1985). Thus, placement of the male sex first in cell series appears to be a response to the nontypical mating system exhibited by many anthidiine bees (Thornhill and Alcock, 1983).

Hicks (1929) reported that *C. illustre* females used resin and an undetermined substance for the final cap on nests. None of the nest entrance plugs of either species reported here contained resin. The material was masticated plant parts mixed with pebbles, dirt, or other organic debris.

This is the first report of *Ascosphaera* attacking *Callanthidium*. Recent trap-nesting studies have yielded many new host records (unpublished data) for this important disease (chalkbrood), and it appears that the disease may be spreading from commercially managed populations of the alfalfa leafcutting bee, *Megachile rotundata* (Fab.) (Parker, 1985b), to populations of native bees (Parker and Frohlich, 1983; Youssef et al., 1985).

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